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plasma processing apparatus to the wafer and the second position does not substantially prevent the diffusion of gases over the wafer within the plasma processing apparatus.

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14. (New) The apparatus as recited in claim 8 wherein the barrier is recessed so as to not disturb an ion-assisted etch process.

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15. (New) The apparatus as recited in claim 8 wherein the barrier is situated below the wafer and within a focus ring such that the barrier is either flush with or below an upper surface of the focus ring in the second position.

REMARKS

Claims 1-15 are now pending in this Application. Claims 1-13 were rejected by the Examiner. Claim 8 has been amended. Claims 14 and 15 have been added. No new matter has been added. Applicants respectfully request reconsideration of the rejections set forth in the Office Action dated June 18, 2002 in view of the preceding amendments and following remarks.

The present invention relates to a diffusion barrier that can be positioned in multiple positions relative to a wafer. One known approach for improving etch rate uniformity in a chemically driven etch process is to install a diffusion barrier around the wafer perimeter. However, diffusion barriers are not used during ion-assisted (or ion-driven) etch processes (e.g. a plasma enhanced etch process). More specifically, the diffusion barrier is believed to quench the plasma and thus disturb the ion density uniformity in the plasma. If the barrier were to be used, the plasma density near the wafer perimeter would be lowered and thus cause a non-uniform etching during an ion assisted/driven etch. Because the diffusion barriers compromise the quality of an ion-driven etch, separate plasma processing chambers are often used when both ion-assisted etching and chemically driven etching is to be performed. Correspondingly, the present invention relates to a semiconductor manufacturing apparatus having a diffusion barrier that can be positioned in multiple positions relative to a wafer. In

one position, the diffusion barrier acts to inhibit diffusion of neutral species which may compromise etch quality of chemically driven etch processes. In another position, the barrier is recessed so as to not disturb an ion-assisted etch process.

Claims 14-15 have been added to capture various aspects of the present invention not previously recited.

Rejections Under 35 U.S.C. § 103

Claims 1-13 are rejected under 35 U.S.C. §103 as being unpatentable over U.S. Patent 5,213,658 to Ishida (hereinafter referred to as “Ishida”) in view of EP Patent 0676790 A1 to Hills et al. (hereinafter referred to as “Hills”). Applicants respectfully traverse.

Firstly, Applicants submit that combining the cited prior art as proposed in the Office Action is improper.

The Examiner asserts that it would have been obvious to modify the moveable focus rings of Ishida with the teachings of Hills. Applicants respectfully disagree. Hills teaches against moveable focus rings (see column 2, lines 16-22 and column 4, lines 14-25). Specifically, he states that moving parts “generate particulate contamination within the reactor chamber 126, thereby increasing the risk of loss of die yield due to such contamination” (column 4, lines 22-25). Applicants respectfully submit that the references must be taken in their entirety, including those portions which argue against an obvious combination. Bausch & Lomb, 230 U.S.P.Q. at 420. Since Hills explicitly teaches against the use of moveable focus rings, and Ishida focuses on moveable focus rings, the combination of Ishida and Hills as proposed in the Office Action is improper.

For prior art references to be combined to render obvious a subsequent invention under Section 103, there must be something in the prior art as a whole that suggests the desirability, and thus the obviousness of, making the combination. In contrast, the combination of prior art cited in the Office Action includes no such motivation; and Hills indeed includes explicit support for non-combination with Ishida. Hills uses focus rings with plural openings because he feels moveable focus rings are detrimental.

For at least these reasons, Applicants respectfully submit that the proposed combination of prior art is improper. In addition to the improper combination, the cited references, either alone or in combination, fail to teach features recited in the independent claims.

Claim 8 has been amended to clarify the present invention and now recites “and the second position does not substantially prevent the diffusion of gases over the wafer within the plasma processing apparatus”. As mentioned above and in the Specification, a diffusion barrier is believed to quench the plasma and thus disturb the ion density uniformity in the plasma during an ion assisted/driven etch. Support for the amendment can be found in the Specification on pages 4, and 7-8, for example. It is respectfully submitted that such an arrangement is neither disclosed nor reasonably suggested by the art of record.

Claim 1 recites “wherein the second position relative to the wafer does not interfere with the etch uniformity of an ion driven etch process”. Again, it is respectfully submitted that no combination of the prior art discloses or reasonably suggests such an arrangement.

The focus ring of Ishida is clearly shown to position well above the wafer (see FIG. 1). Even if the focus ring as illustrated were given maximum translation according to the illustrations of FIGs. 1-4, the focus ring would still be well above the wafer (see FIGs. 1-4) and prevent the diffusion of gases over the wafer (its intended purpose) and interfere with the etch uniformity of an ion driven etch process. Nowhere does Ishida teach that his focus ring is capable of recessing to any point lower than shown, nor does he teach a desire for such positioning. On page 3 of the Office Action dated June 18, 2002, the Examiner asserts that the height of Ishida’s focus ring may be adjusted during the etching operation (column 4, lines 1-9). However, Ishida only teaches one type of etching (chemical). More importantly, Ishida only teaches a desire to move his barrier the height of individual layers on a single wafer for this one etching type, which comprises minimal motion (how much motion is between layers on a wafer?). Thus, in all the drawings and teachings of Ishida, the focus ring would be well above the plane of the wafer, and therefore disturb an ion-assisted etch process. He therefore does not teach or suggest a second type of processing or the positioning of a barrier as recited, or teach or remotely suggest a desire to move his focus ring to facilitate such a process.

Hills does not address these deficiencies, and teaches a focus ring that would interfere with the etch uniformity of an ion driven etch process.

Thus, Ishida and Hills, either alone or in combination, fail to teach “a barrier having a first position ... and having a second position relative to the wafer wherein the second position relative to the wafer does not interfere with the etch uniformity of an ion driven etch process” as recited in claim 1. In addition, Ishida and Hills, either alone or in combination, fail to teach “a moveable barrier having a first position and a second position ... and the second position does not substantially prevent the diffusion of gases over the wafer within the plasma processing apparatus” as recited in amended claim 8. For at least these reasons, the art of record does teach or remotely suggest a barrier as described in independent claims 1 and 8.

Since Ishida and Hills, either alone or in combination, do not teach - or remotely suggest - all the limitations of the independent claims, the cited references, either alone or in combination, fail to render the claimed invention obvious. Hills is concerned with avoiding contamination introduced by moving parts associated with moveable focus rings and teaches away from the limitations of independent claims 1 and 8. Ishida is concerned with optimizing the performance of a focus ring for one type of semiconductor fabrication and does not teach or suggest a second position relative to the wafer that does not interfere with the etch uniformity of a second semiconductor etch process type.

Therefore, Applicants respectfully submit that all aspects of the independent claims are not taught or suggested by the art of record, either alone or in combination; that combining the cited prior art as proposed in the Office Action is improper; and that independent claims 1 and 8 are patentable.

Claims 2-7, and 9-13 each depend either directly from independent claims 1 and 8, respectively, and are therefore respectfully submitted to be patentable over the art of record for at least the reasons set forth above with respect to the independent claims. Further, the dependent claims recite additional elements which when taken in the context of the claimed invention further patentably distinguish the art of record.

For example, new dependent claim 14 recites “wherein the barrier is situated below the wafer and within a focus ring such that the barrier is either flush with or below an upper surface of the focus ring in the second position”. Applicants note that


the Examiner has used a barrier and a focus ring synonymously, and that Ishida and Hills both teach one focus ring in their respective apparatus. Logically then, the art of record cannot be used to teach or suggest both a barrier and a focus ring as recited in dependent claim 15.

Withdrawal of the rejection of claims 1-13 based on 35 U.S.C. § 103(a) is therefore respectfully requested.

Conclusion

In view of the foregoing, Applicants believe that all pending claims are allowable and respectfully requests early Notice of Allowance from the Examiner. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at the telephone number set out below. If any fees are due in connection with the filing of this paper, the Commissioner is authorized to charge such fees to Deposit Account 50-0388 (Order No. LAM1P111).

Respectfully submitted,
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Limited Recognition under 37 C.F.R. §10.9(b)

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APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Claims:

8. (Once Amended) A plasma processing apparatus comprising:

a chuck for supporting a wafer; and

a moveable barrier having a first position and a second position, wherein the first position is capable of restricting diffusion of gases over the wafer within the plasma processing apparatus to the wafer and the second position does not substantially prevent the diffusion of gases over the wafer within the plasma processing apparatus.

14. (New) The apparatus as recited in claim 8 wherein the barrier is recessed so as to not disturb an ion-assisted etch process.

15. (New) The apparatus as recited in claim 8 wherein the barrier is situated below the wafer and within a focus ring such that the barrier is either flush with or below an upper surface of the focus ring in the second position.